SPECIFICATION

Docket Number: **RR2154**

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, **Kim Chang** and **Robert E. Denman**, both citizens of the United States of America, and **Chenhong Huang**, a citizen of People Republic of China, all residing in the State of Texas, have invented new and useful improvements in an

ENHANCED METHOD AND SYSTEM FOR PROGRAMMING A MOBILE TELEPHONE OVER THE AIR WITHIN A MOBILE TELEPHONE COMMUNICATION NETWORK

of which the following is a specification:

BACKGROUND OF THE INVENTION

This Application Claims Benefit of Provisional Application Ser No 60/039 193 Filed March 17 1997.

1. Technical Field

The present invention relates to a method and system for servicing a wireless communication network in general, and in particular to a method and system for servicing a mobile telephone communication network. Still more particularly, the present invention relates to an enhanced method and system for programming a mobile telephone over the air within a mobile telephone communication network.

2. Description of the Prior Art

A mobile telephone communication network is an integrated network comprising a land-based wireline telephone network and a composite wired-wireless network. The land-based wireline network is the traditional telephone system in which each telephone subscriber is connected to a central switching network, commonly known as the public switched telephone network (PSTN), capable of handling thousands of simultaneous telephone calls. The composite wire-wireless network is the basis of today's mobile telephone communication network. The heart of the composite wire-wireless network is a wireless-specific switch, which is generally known as a mobile switching center (MSC), derived from PSTN switches by adding several functions that are pertinent to the mobile telephone communication network. Along with the MSC, a base station controller (BSC) is utilized to control base stations located at different convenient sites within the mobile telephone communication network. The coverage of each base station varies from less than a kilometer to several kilometers, depending on the propagation environment and traffic density.

A mobile telephone communication network is designed to serve mobile telephone subscribers within a given geographic area, known as a metropolitan service area (MSA). A typical mobile telephone communication network has the capacity to serve thousands of mobile telephone subscribers within a large MSA. Mobile telephone subscribers are expected to subscribe services from a mobile telephone service provider for services within a specific MSA. When the mobile telephone subscriber operates within its subscribed MSA, the mobile telephone subscriber is referred to as a home mobile, while outside of its subscribed MSA the mobile telephone subscriber is referred to as a roamer.

The first objective of a mobile telephone service is to provide dial access between home mobiles and any other telephones (landline or mobile) reached through the PSTN. The second objective of the mobile telephone service is to provide access to and from roamers. In order to satisfy both of the above-mentioned objectives, it is essential for the subscriber's mobile telephone to have a standard 10-digit telephone number, including a three-digit area code plus a seven-digit directory number. A 34-bit binary mobile identification number (MIN), which may sometimes be derived from the 10-digit telephone number, identifies an individual mobile telephone subscriber within the mobile telephone communication network.

For calls originated by a mobile telephone subscriber, the mobile telephone communication network not only needs the dialed digits but also requires the originating mobile telephone subscriber's identification. Such identification, including the MIN, is stored in a number assignment module (NAM), which is part of the mobile telephone. Under the prior art, the NAM is programmed by a mobile telephone service provider when the mobile telephone subscriber initially subscribes for service. Once the NAM has been programmed,

the mobile telephone must be physically brought back to the original service provider (or a new service provider) in order to change the information within the NAM.

With the advent of the Over-the-Air Service provisioning (OTASP), a mobile telephone subscriber is provided with more flexibility. As the term "over-the-air service" implies, OTASP allows some of the operating parameters within a mobile telephone to be changed by a mobile telephone communication network over the air via an over-the-air function/customer service center (OTAF/CSC). Nevertheless, once a mobile telephone has been initially programmed, the OTAF/CSC still has no convenient way of knowing the capability of the mobile telephone that is in use, such as whether the mobile telephone supports cellular or personal communication service, dual-band or single band, analog or digital, etc. This information is essential for the OTAF/CSC to determine which preferred roaming list (PRL) and NAM indicator block are to be constructed and downloaded to the requesting mobile telephone. In addition, when a mobile telephone is to be activated for additional service, the OTAF/CSC again has no convenient way of knowing which service options the mobile telephone may support. This service options information is critical for allowing the OTAF/CSC to initiate appropriate provisioning of the mobile telephone in a home locate register (HLR), when the mobile telephone subscriber wishes to subscribe to some special services such as short message services (SMS). Consequently, it is desirable to provide an improved method for programming a mobile telephone over the air within a mobile telephone communication network.

SUMMARY OF THE INVENTION

In view of the foregoing, it is therefore an object of the present invention to provide an improved method for servicing a wireless communication network.

It is another object of the present invention to provide an improved method and system for servicing a mobile telephone communication network.

It is yet another object of the present invention to provide an improved method and system for programming a mobile telephone over the air within a mobile telephone communication network.

In accordance with a method and system of the present invention, a mobile telephone communication network includes an over-the-air function, a customer service center, a mobile switching center, a base station controller, and multiple base transceiver stations. The over-the-air function, using the mobile switching center, base station controller and one of the base transceiver stations for transport, initially sends a request over the air to a mobile telephone within the mobile telephone communication network to interrogate the mobile telephone's protocol capability. In response to the request, the mobile telephone sends a protocol capability response message over the air back to the over-the-air function. The protocol capability response message includes a BAND_MODE_CAP field that describes the band and mode capability information of the mobile telephone. In addition, the protocol capability response message may also includes a SERVICE_OPTION field that describes the service options supported by the mobile telephone.

All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself, as well as a preferred mode of use, further objects, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawing, wherein:

Figure 1 is a pictorial diagram of a mobile telephone communication network in which a preferred embodiment of the present invention may be implemented.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings and in particular to Figure **1**, there is depicted a pictorial diagram of a mobile telephone communication network **10** in which a preferred embodiment of the present invention may be implemented. Communication network **10** may utilize an analog protocol such as advanced mobile phone service (AMPS) or a digital protocol such as code-division multiple access (CDMA). As shown, communication network **10** includes several base transceiver stations (BTSs) **12a-12n** located at various locations within communication network **10**. Each of BTSs **12a-12n** is controlled by a base station controller (BSC) **11**. Within the service area of communication network **10**, there are several mobile telephones, such as mobiles **13a**, **13b**, **13c**, **13d** and **13e**. Constant communications must be maintained between a mobile and at least one of BTSs **12a-12n** when the mobile is being utilized to communicate with another telephone.

Coupled to BSC **11** is a mobile switching center (MSC) **14** for supporting multiple-access technologies such as AMPS and CDMA, and connectivity to a public switched telephone network (PSTN) **19**. In addition, MSC **14** supports various call processing functions. Along with BSC **11** and MSC **14**, an Over-the-Air Function (OTAF) **15** allows a mobile telephone subscriber to activate and program a mobile, such as one of mobiles **13a-13e**, without the intervention of a third party. OTAF **15** also allows a mobile telephone service provider to modify, over the air, certain operating parameters previously stored within mobiles **13a-13e**. These parameters include number assignment module (NAM) indicators such as a mobile identification number (MIN) and a mobile directory number, a preferred roaming list, and a service programming code. A detailed specification for the OTASP operation can be found in "Over-the-Air Service Provisioning of Mobile Stations in Spread

Spectrum Systems" (TIA/EIA/IS-683-A), which is incorporated herein by reference.

Typically, a computer system **16** is located within OTAF **15** for performing the over-the-air programming function. Computer system **16** may be, for example, a midrange computer having a processor and a main memory as is well-known to those skilled in the art. The software for performing the over-the-air programming commonly resides within computer system **16**. In addition, OTAF **15** is coupled to a customer service center (CSC) **17**, which connects to a home locate register (HLR) **18**. CSC **17** initiates OTAF operations, and provides an operator with the means for voice conversations with the subscriber whose mobile is being programmed. The voice data exchanged betweeen the operator and the subscriber transits from CSC **17**, PSTN **19**, MSC **14**, BSC **11**, and BTS **12a-12n** to mobiles **13a-13e**. CSC **17** also receives status from OTAF **15** related to the programming of mobiles **13a-13e**. Finally, CSC **17** may initiate creation of a modification to the subscriber's profile in HLR **18**. The subscriber's profile includes an indentification of the mobile's directory number, MIN, and various service options.

As mentioned previously, an appropriate NAM indicator needs to be programmed into a mobile for the proper functioning of the mobile. There are two types of NAM indicators: (1) a Personal Communication System (PCS) indicator for mobiles capable of operating in the PCS band (1.9 GHz), and (2) a cellular indicator for mobiles capable of operating in the cellular band (800 MHz). In addition, an appropriate preferred roaming list (PRL) is required for roaming support of the mobile. A PRL is essentially a system table for assisting the mobile to locate a preferred mobile communication network upon power-on of the mobile when it is located outside the mobile's subscribed service area. A

PRL can include entries specifying mobile communication networks in different regions, including the bands and operation modes.

Any one of mobiles **13a-13e** within mobile telephone communication network **10** may be programmed by OTAF **15** via one of base transceiver stations **12a-12n**. Preferably, MSC **14**, BSC **11**, and base transceiver stations **12a-12n** simply provide transport between OTAF **15** and mobiles **13a-13e** for the actual exchanges of the protocol capability requests and responses. Before programming, OTAF **15** needs to send a request to a mobile, via one of BTSs **12a-12n**, to interrogate the mobile's protocol capability, and the mobile will respond with a protocol capability response message. With reference now to Table **I**, there is depicted a list of parameters in a protocol capability response message from a mobile to a base transceiver station over the air within mobile telephone communication network **10**, in accordance with a preferred embodiment of the present invention.

Table I

Field	Length (bits)
OTASP_MSG_TYPE	8
MOB_FIRM_REV	16
MOB_MODEL	8
NUM_FEATURES	8
FEATURE_ID	8
FEATURE_P_REV	8
BAND_MODE_CAP	8
NUM_SO	8
SERVICE_OPTION	16

The OTASP_MSG_TYPE field describes a message type of OTASP compliant data. The OTASP_MSG_TYPE field is an eight-bit field, and is preferably set by the mobile to "00000110" to indicate the present message as a protocol capability response message.

The MOB_FIRM_REV field describes a firmware revision number of the mobile. The MOB_FIRM_REV field is a 16-bit field, and is preferably set by the mobile to the value of the permanent mobile station indicator, MOB_FIRM_REV_p.

The MOB_MODEL field describes a model number of the mobile assigned by the mobile manufacturer. The MOB_MODEL field is an eight-bit field, and is preferably set by the mobile to the value of the permanent mobile station indicator, MOB_MODEL_p.

The NUM_FEATURES field describes the number of features supported by the mobile. The NUM_FEATURES field is an eight-bit field, and is preferably set by the mobile to indicate the total length of the subsequent bits for indicating all the features supported by the mobile. Each individual feature is described by two fields, namely, a FEATURE_ID field and a FEATURE_P_REV field. Hence, if there are two features, NUM_FEATURES field will be set to "00000010" along with two FEATURE_ID fields and two FEATURE_P_REV fields, interleaving each other (*i.e.*, FEATURE_ID field, FEATURE_P_REV field, FEATURE_ID field, FEATURE_P_REV field).

The FEATURE_ID field describes a feature identifier. The FEATURE_ID field is an eight-bit field, and is preferably set according to one of the entries under the FEATURE_ID column in Table II to indicate a specific feature supported by the mobile.

Table II

Features	FEATURE_ID	FEATURE_P_REV
NAM download	00000000	00000010 or less
key exchange	00000001	00000001 or less
system selection for preferred roaming	00000010	00000000
service programming lock	00000011	00000001 or less
reserved for future standardization	00000100 through 10111111	
available for manufacturer-specific features	11000000 through 11111110	
reserved	11111111	

The FEATURE_P_REV field describes a feature protocol version. The FEATURE_P_REV field is an eight-bit field, and is preferably set according to one of the entries under the FEATURE_P_REV column in Table II to indicate a protocol version of the specific feature supported by the mobile.

Even with the OTASP, the OTAF/CSC still has no convenient way of knowing the mobile's capability, such as whether the mobile communicates utilizing a cellular band or a PCS band, with dual band or single band, an AMPS mode or a CDMA mode, or with dual mode or single mode, unless the mobile can relate such information to the OTAF/CSC. The above-mentioned information related to the mobile's capability is essential for the OTAF/CSC to determine which PRL(s) and NAM indicator block(s) should be downloaded to the

requesting mobile. Under the prior art, there are only two options available to the mobile telephone service provider. This first option is to construct a global PRL that can be utilized by all mobiles, regardless of their capabilities, and the second option is to establish some sort of databases associated with the electronic serial number or the model number of the mobiles. Needless to say, extraneous information is likely to be downloaded to the requesting mobile under the first option, and the databases in the second option are typically quite large and are probably difficult to maintain.

In accordance with a preferred embodiment of the present invention, a BAND_MODE_CAP field is utilized to allow the mobile telephone service provider to obtain the capability of the mobile over the air, such that a custom PRL and NAM indicator block specific to the mobile's capability can be downloaded to the mobile. The BAND_MODE_CAP field describes the band/mode capability information of the mobile. The BAND_MODE_CAP field is an eight-bit field, and is preferably set by the mobile to indicate the mobile's band and mode capabilities, such as whether the mobile communicates utilizing a cellular band or a PCS band, with dual band or single band, and whether the mobile utilizes an AMPS mode or a CDMA mode, with dual mode or single mode. The BAND_MODE_CAP field includes several subfields as shown in Table III. Subfield "band Class 0 AMPS" indicates whether the mobile is capable of AMPS mode in a cellular band. Subfield "band Class 0 CDMA" indicates whether the mobile is capable of CDMA mode in a cellular band. Subfield "band Class 1 CDMA" indicates whether the mobile is capable of CDMA mode in a PCS band. Each subfield within BAND_MODE_CAP field is preferably set to "1" if the corresponding type of band/mode is supported by the mobile. The reserved subfield is preferably set to "00000."

Table III

Description	Length (bits)
band Class 0 AMPS	1
band Class 0 CDMA	1
band Class 1 CDMA	1
reserved	5

In addition, when a mobile is to be activated for additional service, the OTAF has no convenient way of knowing which service options the mobile may support. This service options information is critical for allowing the OTAF to initiate certain provisioning of the mobile in a home locate register (HLR), when the mobile telephone subscriber wishes to subscribe to some special services such as short message services. Thus, the NUM_SO field is utilized to describe a number of service options available to the mobile.

The NUM_SO field is an eight-bit field, and is preferably set to the number of service options supported by the mobile. Similar to the NUM_FEATURES field, the NUM_SO field indicates the total number of the subsequent SERVICE_OPTION field(s) for indicating all the service options supported by the mobile.

The SERVICE_OPTION field describes all supported service options. The SERVICE_OPTION field is a 16-bit field, and is preferably set to the service option code column in accordance with Table IV. The type of service associated with each service option code in also described in Table IV.

Table IV

service option code (in decimal)	Designated/Type of Service
1	Basic Variable Rate Voice Service (8 kbps)
2	Mobile Station Loopback (8 kbps)
3	Enhanced Variable Rate Voice Service (8 kbps)
4	Asynchronous Data Service (9.6 kbps)
5	Group 3 Facsimile (9.6 kbps)
6	Short Message Services (rate set 1)
7	Packet Data Service: Internet or ISO Protocol Stack
8	Packet Data Service: CDPD Protocol Stack
9	Mobile Station Loopback (13 kbps)
10	STU-III Transparent Service
11	STU-III Non-Transparent Service
17	Asynchronous Data Service (14.4 or 9.6 kbps)
13	Group 3 Facsimile (14.4 or 9.6 kbps)
14	Short Message Services (rate set 2)
15	Packet Data Service: Internet or ISO Protocol Stack (14.4 kbps)
16	Packet Data Service: CDPD Protocol Stack (14.4 kbps)
17	High Rate Voice Service (13 kbps)
18	Over-the-Air Parameter Administration (Rate Set 1)
19	Over-the-Air Parameter Administration (Rate Set 2)
20	Group 3 Analog Facsimile (Rate Set 1)
21	Group 3 Analog Facsimile (Rate Set 2)
22-4099	Reserved for standard service options

4100	Asynchronous Data Service Revision 1 (9.6 or 14.4 kbps)
4101	Group 3 Facsimile Revision 1 (9.6 or 14.4 kbps)
4102	Reserved for standard service option
4103	Packet Data Service: Internet or ISO Protocol Stack Revision 1 (9.6 or 14.4 kbps)
4104	Packet Data Service: CDPD Protocol Stack Revision 1 (9.6 or 14.4 kbps)
4105-32.767	reserved for standard service options

As has been described, the present invention provides an enhanced method for programming a mobile telephone over the air within a mobile telephone communication network. In addition to mobiles, the present invention is also applicable to fixed wireless access applications. The computer system for implementing the present invention preferably resides in an OTAF. It is important to note that the mechanisms of the present invention are capable of being distributed as a program product in a variety of forms, and that the present invention applies equally regardless of the particular type of signal bearing media utilized to actually carry out the distribution. Examples of signal bearing media include, without limitation, recordable type media such as floppy disks or CD ROMs and transmission type media such as analog or digital communications links.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.